# Assessing the Threat of Undersampled Ionospheric Irregularities for Wide Area Differential GPS Systems

Users of wide area differential GPS systems such as the Wide Area Augmentaion System (WAAS) require accurate calibration of ionospheric delays. Under nominal quiet-time conditions, a planar fit of slant delay measurements projected to vertical provides estimates of the local vertical delay that are of sufficient accuracy for WAAS operation. Under storm conditions this ceases to be true. Ionospheric disturbances generally consist of irregularities that occur simultaneously on many spatial scales rather than in isolation, a critical fact that favors algorithm integrity. Large ionospheric irregularities do not pose a serious threat to WAAS as they can be easily identified by an irregularity detector and treated by the WAAS system as manifestations of storm conditions (Walter et al., 2000). The worst-case threat posed by the ionosphere consists not of irregularities of large magnitude but rather more modest irregularities that are almost, but not quite, severe enough to trip the irregularity detector that indicates the presence of a storm.

The goal of the irregularity threat model described in this paper is to provide a quantitative basis for estimating the magnitudes of delay errors associated with ionospheric irregularities that escape detection by the WAAS system. The threat model is derived from an analysis of spatial and temporal correlations between deviations of vertical delay from planarity during *non-storm* (or more precisely, *near-storm*) conditions. The analysis is based on data obtained from operational receivers in the WAAS reference station network. The products of the analysis are histograms constructed by examining pairs of measurements and tabulating the differences between their deviations from planarity. These deviations are binned according to the distance and time separating the measurements and their dependence on the level of ionospheric disturbance as indicated by the goodness of the planar fit. Overbounds of such histograms (*i.e.*, envelopes below which all binned data fall) quantify the most severe threats under near-storm conditions. The threat model is formulated in terms of polynomial fits to these overbounds.

Walter, Todd *et al.*, "Robust Detection of Ionospheric Irregulariites" in proceedings of ION GPS, Salt Lake City, UT, September 2000.